Delta Outflows and Related Stressors Workshop Charge

December 6, 2013

Workshop Purpose

The purpose of this workshop is to identify the best available science to inform the State Water Resources Control Board's (State Water Board) decisions regarding Delta outflow requirements included in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). Delta outflow requirements include both flow objectives and measures that should be included in the program of implementation. The purpose of this workshop is not to discuss environmental impacts, economic effects or balancing issues which will be part of Substitute Environmental Document (SED) and related water quality control planning process supporting the update of the Bay-Delta Plan. An independent panel of science experts (panel) will be provided key scientific papers, reports, and presentations to respond to the following charge questions developed to guide the panel's work.

The panel will summarize their findings on the charge questions in a written report to the Delta Stewardship Council/Delta Science Program (DSP) and State Water Board. The report will then be one piece of information that informs the State Water Board's update to the Bay-Delta Plan along with other scientific information concerning needed measures to protect beneficial uses in the Bay-Delta and information concerning the environmental, water supply, agricultural, hydropower, and economic effects of alternative Bay-Delta Plan requirements. The scientific basis and above effects analyses will all be included in the draft SED that supports the State Water Board's review of the Bay-Delta Plan. There will be opportunities for the public to review and comment on the draft SED and associated analyses prior to finalization and action by the State Water Board on any changes to the Bay-Delta Plan related to Delta outflows. As a result, there will be other forums and ample opportunity for the public to participate in the development of other information not addressed in this workshop.

Background

The State Water Board is currently undertaking a phased process to develop and implement updates to the Bay-Delta Plan and flow objectives for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed. The Bay-Delta Plan identifies beneficial uses of water in the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, a program of implementation for achieving the water quality objectives and an associated surveillance and monitoring program. Phase 1 of the review of the Bay-Delta Plan is focused on southern Delta water quality and San Joaquin River flows. Phase 2 (Comprehensive Review) is focused on other changes that may be needed to the remainder of the Bay-Delta Plan to protect fish and wildlife beneficial uses, including: (1) Delta outflows, (2) export constraints, (3) Delta Cross Channel Gate closure requirements, (4) Suisun Marsh requirements ; (5) Old and Middle River reverse flows; (6) floodplain habitat flows; (7) changes to the monitoring and special studies program, and (8) other potential changes to the program of implementation. Phase 3 involves changes to water rights and other measures to implement changes to the Bay-Delta Plan from Phases 1 and 2. Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay-Delta Plan updates.

To inform the scientific and technical basis for considering potential changes to the Bay-Delta Plan as part of Phase 2, the State Water Board held the following technical workshops:

Date	State Water Board Workshop
September 5 and 6, 2012	Ecosystem Changes and the Low Salinity Zone
October 1 and 2, 2012	Bay-Delta Fishery Resources
November 13 and 14, 2012	Analytical Tools for Evaluating the Water Supply, Hydrodynamics, and Hydropower Effects of the Bay-Delta Plan

The workshops were facilitated by the State Water Board's consultant Dr. Brock Bernstein. During the workshops, an independent expert panel organized by Dr. Peter Goodwin, Lead Scientist for the DSP, agencies and stakeholder groups presented information related to the topics listed above. The information presented identified several areas of scientific disagreement and uncertainty, as well as some areas of agreement. In January 2013, Dr. Bernstein, in cooperation with ICF International, released a draft report summarizing the workshops' key points, including the areas of agreement and disagreement, sources of disagreement and degree of certainty. In July 2013, Dr. Bernstein released the final report, which is comprised of the draft report and comments submitted on the draft report. [1]

At its April 9, 2013 meeting, the State Water Board held an informational item on next steps related to the draft summary report. The purpose of the informational item was to receive input on the next steps for Phase 2. More specifically, the State Water Board sought input on what areas of disagreement or uncertainty identified in the summary report should be resolved during the comprehensive review of the Bay-Delta Plan, and what process should be used to resolve those issues. At the informational item, Dr. Goodwin recommended that the DSP hold a series of technical workshops to provide input on the best available scientific information to inform the State Water Board's Phase 2 process. Specifically, the DSP proposed the following workshops to focus on critical questions arising from the State Water Board's fall 2012 workshops:

1. Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed[2]
2. Delta Outflows and Related Stressors
3. Interior Delta Flow Operational Parameters and Related Stressors
4. Effects of Nutrient Enrichment in the Bay-Delta Ecosystem

To plan and develop the workshop materials for the workshop on Delta Outflows and Related Stressors, a planning group was convened with a representative group of stakeholder interests. That stakeholder group provided input on the development of this workshop with final approval of all substantive materials made by the Lead Scientist.

Regulatory Context

The State Water Resources Control Board and the nine Regional Water Quality Control Boards (Water Boards) have broad responsibilities to protect surface and ground water

[1] The draft Workshop Summary Report and other information concerning the workshops and the State Water Board's review of the Bay-Delta Plan can be found at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/comp_review.shtml.

[2] A workshop on Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed was held July 22-23, 2013. The workshop summary report is available at http://deltacouncil.ca.gov/sites/default/files/documents/files/Fish_Predation_Final_Report_9_30_13.pdf.

quality and balance competing demands on California water resources through programs that allocate water rights, adjudicate water right disputes, develop statewide and regional water quality control plans and implement and enforce those plans. The State Water Board allocates water rights through an administrative system that is intended to maximize the beneficial uses of water while protecting the public trust, serving the public interest, and preventing the waste and unreasonable use or method of diversion of water. The State Water Board protects water quality by establishing water quality control plans, implementing those plans and enforcing that implementation. Water Quality Control Plans identify existing and potential beneficial uses of waters of the state and establish water quality objectives and implementation measures to reasonably protect the identified beneficial uses along with surveillance and monitoring requirements. While most water quality control planning is done by the Regional Water Quality Control Boards, the State Water Board has authority to adopt statewide Water Quality Control Plans and adopts the Bay-Delta Plan because of the overlapping water quality and water rights issues of statewide significance in the Bay-Delta.

The Bay-Delta Plan includes beneficial uses that fall into three broad categories including: fish and wildlife, agricultural, and municipal and industrial uses. The current Bay-Delta Plan includes water quality objectives to protect the three categories of beneficial uses including: inflows from the Sacramento and San Joaquin Rivers; Delta outflows; water project operations; dissolved oxygen; narrative salmon protection; and various salinity objectives for the protection of fish and wildlife, agriculture, and municipal and industrial uses. The program of implementation identifies actions needed to protect beneficial uses and implement the water quality objectives, including actions the State Water Board will take, actions that the State Water Board will take with other entities, and actions that other entities should take, including non-flow and water quality actions.

The Bay-Delta Plan like other Water Quality Control Plans is not self-implementing and requires additional actions to be implemented. The primary mechanism for implementing the Bay-Delta Plan in the past has been through the State Water Board's water rights authorities. The water quality control planning process and water rights implementation processes are separate processes governed by separate statutory and regulatory requirements. The water quality control planning process is a quasi-legislative planning process, whereas the water rights process is a more formal evidentiary quasi-judicial process.

Pursuant to state and federal law, the State Water Board is required to regularly review the Bay-Delta Plan to determine what, if any, changes should be made to the Bay-Delta Plan to protect beneficial uses. The State Water Board conducted a review of the current 2006 Bay-Delta Plan in 2009. As a result of several species declines in the Bay-Delta that may be associated with Bay-Delta Plan requirements the State Water Board determined that Delta outflows and other requirements for the protection of fish and wildlife beneficial uses should be considered for potential amendment to ensure the protection of fish and wildlife beneficial uses. The State Water Board started the process of updating the Bay-Delta Plan with Phase 1 in 2009 and Phase 2 in 2012. The update process is being conducted in compliance with applicable statutory and regulatory requirements, including the California Environmental Quality Act (CEQA). The Water Quality Control Planning process is a Certified Regulatory Process pursuant to CEQA. Accordingly, the State Water Board is exempt from preparing an Environmental Impact Report (EIR) for its review. Instead, the State Water Board is preparing a SED that is functionally equivalent to a programmatic EIR. In addition to the evaluation of environmental impacts, the SED will also evaluate economic effects and other public interest considerations at a programmatic level. All of this information will be used along with public comments from the public to inform the State Water Board's decisions regarding changes to the

Bay-Delta Plan. Prior to implementation through water rights and other measures, additional project specific environmental documentation will be prepared as necessary and other statutory and regulatory requirements will be met.

Charge to the Panel

The Panel is charged with reviewing and assessing the provided written materials and oral presentations in order to identify the best available science to inform the State Water Board's decisions on Bay-Delta Plan requirements related to Delta outflow and related factors (Delta outflow requirements). The Panel will evaluate and synthesize the best available scientific information and prepare a report that addresses the following questions:

1. What are the key studies and synthesis reports that the State Water Board should rely on in making their decisions on Delta outflow requirements? Please comment on the strength and relevance of the science presented and reviewed.

2. The existing Delta outflow objectives are based largely on documented relationships between a suite of estuarine organisms and the 2 ppt isohaline (X2).
   - Should these flow relationships still be used as the basis for protecting estuarine fish, estuarine fish habitat, and other important ecosystem attributes?
   - Are there other methods or indicators available to serve as the basis for protecting estuarine fish, estuarine fish habitat, and other important ecosystem attributes? If so, what are they and how could they be applied?

3. What scales (magnitude and duration) of outflow change are needed to produce measurable changes in native species population viability and/or ecosystem function over what time frame? Are there thresholds for achieving specific responses? How could adaptive management experiments be conducted on these scales to inform manipulation of Delta outflow to better protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?

4. How are other factors that affect estuarine fish, estuarine fish habitat, and other ecosystem attributes likely to interact with Delta outflow requirements?
   - Are there tools or methods available that could help the State Water Board to better assess the interactions between flow and other factors that affect the estuarine fish, estuarine fish habitat, and other important ecosystem attributes?
   - Can we reasonably expect that addressing other stressors without addressing flow will lead to specific improvements in the status of estuarine fish, estuarine fish habitat, and other important ecosystem attributes?
   - Conversely, can we reasonably expect that addressing flow without addressing other stressors will lead to specific improvements in the status of estuarine fish, estuarine fish habitat, and other important ecosystem attributes?

5. How should Delta outflow be measured and managed to better reflect the flows necessary to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?

- To what extent does managing winter-spring outflow by X2 reflect the flows necessary to protect estuarine fish? Are there other approaches to managing winter-spring outflow that could improve our ability to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?
- How should summer-fall outflow be measured and managed to better reflect the flows necessary to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes? Are there other approaches to managing summer-fall outflow that could improve our ability to protect estuarine fish, estuarine fish habitat, and other important ecosystem attributes?

Materials

General Background

ICF. 2013. Final Bay-Delta Plan Workshops Summary Report. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/docs/bdwrkshprpt070813.pdf

NRC. 2010. A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California's Bay Delta.

NRC. 2012. Sustainable Water and Environmental Management in the California Bay-Delta.

SWRCB. 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf

USEPA. 2012. Workshop Summary: Technical Workshop on Estuarine Habitat in the Bay Delta Estuary. Convened by USEPA 3/27/2012. Report prepared by Dr. Brock Bernstein.

USFWS. 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP), - RPA Component 3, pp. 282-283. http://www.fws.gov/sfbaydelta/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf

Literature in Review

IEP. 2012. Draft 2012 FLaSH study report. http://deltacouncil.ca.gov/sites/default/files/documents/files/FLaSH_combined_7_0_12.pdf

IEP. 2013. Draft 2013 MAST report. http://www.water.ca.gov/iep/docs/mast_draft_7-21-13.pdf and http://www.water.ca.gov/iep/docs/mast_figures_7-21-13withFigureNumbers.pdf.

Peer-reviewed Literature

Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* 3(2):1. http://escholarship.org/uc/item/0725n5vk.

Bennett, W.A., W.J. Kimmerer, and J.R. Burau. 2002. Plasticity in vertical migration by native and exotic estuarine fishes in a dynamic low-salinity zone. *Limnology and Oceanography* 47:1496-1507.

Cloern, J.E. and A.D. Jassby. 2012. Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay. *Reviews of Geophysics* 50, RG4001, doi:10.1029/2012RG000397.

Dugdale, R.C., F.P. Wilkerson, V.E. Hogue, and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. *Estuarine, Coastal and Shelf Science* 73(1-2):17-29.

Dugdale, R., F. Wilkerson, A.E. Parker, A. Marchi, and K. Taberski. 2012. River flow and ammonium discharge determine spring phytoplankton blooms in an urbanized Estuary. *Estuarine, Coastal and Shelf Science*, 115:187-199.

Dugdale, R.C., F.P. Wilkerson, and A.E. Parker. 2013. A biogeochemical model of phytoplankton productivity in an urban estuary: The importance of ammonium and freshwater flow. *Ecological Modelling* 263:291-307.

Enright, C. and S.D. Culberson. 2009. Salinity trends, variability, and control in the northern reach of the San Francisco Estuary. *San Francisco Estuary and Watershed Science* 7(2):3. http://escholarship.org/uc/item/0d52737t.

Feyrer, F., K. Newman, M. Nobriga, and T. Sommer. 2011. Modeling the effects of future outflow on the abiotic habitat of an imperiled estuarine fish. *Estuaries and Coasts* 34:120-128.

Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, USA. *Canadian Journal of Fisheries and Aquatic Sciences* 64(4):723-734.

Hobbs, J.A., W.A. Bennett, and J.E. Burton. 2006. Assessing nursery habitat quality for native smelts (*Osmeridae*) in the low-salinity zone of the San Francisco Estuary. *Journal of Fish Biology* 69:907-922.

Jassby, A.D. 2008. Phytoplankton in the Upper San Francisco Estuary: recent biomass trends, their causes and their trophic significance. *San Francisco Estuary and Watershed Science* 6(1):2. http://escholarship.org/uc/item/71h077r1.

Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine applications. *Ecological Applications* 5(1):272-289.

Kimmerer, W.J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? *Marine Ecology and Progress Series* 243:39-55.

Kimmerer, W. 2004. Open Water Processes of the San Francisco Estuary: From Physical Forcing to Biological Responses. *San Francisco Estuary and Watershed Science* 2(1):1. http://escholarship.org/uc/item/9bp499mv.

Kimmerer, W.J. 2005. Long-term changes in apparent uptake of silica in the San Francisco estuary. *Limnology and Oceanography* 50:793-798.

Kimmerer, W.J. 2006. Response of anchovies dampens effects of the invasive bivalve *Corbula amurensis* on the San Francisco Estuary foodweb. *Marine Ecology Progress Series* 324:207-218.

Kimmerer, W.J., W.A. Bennett, and J.R. Burau. 2002. Persistence of tidally-oriented vertical migration by zooplankton in a temperate estuary. *Estuaries* 25:359-371.

Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? *Estuaries and Coasts* 32:375-389.

Kuivila, K.M. and Hladik, M.L. 2008. Understanding the occurrence and transport of current-use pesticides in the San Francisco Estuary Watershed. *San Francisco Estuary and Watershed Science* 6(3):2. http://repositories.cdlib.org/jmie/sfews/vol6/iss3/art2.

Lucas, L.V., J.K. Thompson, and L.R. Brown. 2009. Why are diverse relationships observed between phytoplankton biomass and transport time? *Limnology and Oceanography*, 54(1): 381–390.

Mac Nally, R., J.R. Thomson, W.J. Kimmerer, F. Feyrer, K.B. Newman, A. Sih, W.A. Bennett, L. Brown, E. Fleishman, S.D. Culberson, and G. Castillo. 2010. An analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling. *Ecological Applications* 20(5):1417-1430.

Matern, S.A., P.B. Moyle, and L.C. Pierce. 2002. Native and alien fishes in a California estuarine marsh: twenty-one years of changing assemblages. *Transactions of the American Fisheries Society*, 131:797-816.

Maunder, M.N. and R.B. Deriso. 2011. A state-space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to Delta Smelt (*Hypomesus transpacificus*). *Canadian Journal of Fisheries and Aquatic Sciences* 68:1285-1306.

Miller, W.J., B.F.J. Manly, D.D. Murphy, D. Fullerton, and R.R. Ramey. 2012. An investigation of factors affecting the decline of delta smelt (*Hypomesus transpacificus*) in the Sacramento-San Joaquin Estuary. *Reviews in Fisheries Science*, 20:1, 1-19.

Monismith, S.G., W.J. Kimmerer, J.R. Burau, and M.T. Stacey. 2002. Structure and flow-induced variability of the subtidal salinity field in northern San Francisco Bay. *Journal of Physical Oceanography* 32:3003-3019.

Murphy, D.D. and S.A. Hamilton. 2013. Eastward Migration or Marshward Dispersal: Exercising Survey Data to Elicit an Understanding of Seasonal Movement of Delta Smelt. *San Francisco Estuary and Watershed Science* 11(3). http://escholarship.org/uc/item/4jf862qz.

Nobriga, M., T. Sommer, F. Feyrer, and K. Fleming. 2008. Long-term trends in summertime habitat suitability for delta smelt, *Hypomesus transpacificus*. *San Francisco Estuary and Watershed Science* 6(1):1. http://escholarship.org/uc/item/5xd3q8tx.

Parchaso, F. and J.K. Thompson. 2002. Influence of hydrologic processes on reproduction of the introduced bivalve *Potamocorbula amurensis* in Northern San Francisco Bay, California. *Pacific Science*, 56(3):329-345.

Rosenfield, J.A. 2010. Life History Conceptual Model and Sub-Models for Longfin Smelt, San Francisco Estuary Population. Delta Regional Ecosystem Restoration Implementation Plan. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=28421.

Ruhl, C.A. and D.H. Schoellhamer. 2004. Spatial and temporal variability of suspended-sediment concentrations in a shallow estuarine environment. *San Francisco Estuary and Watershed Science* 2(2):1. http://escholarship.org/uc/item/1g1756dw.

Schoellhamer, D.H. 2001. Influence of salinity, bottom topography, and tides on locations of estuarine turbidity maxima in northern San Francisco Bay, in McNally, W.H. and Mehta, A.J., ed., *Coastal and Estuarine Fine Sediment Processes*. Elsevier, Amsterdam, The Netherlands.

Schoellhamer, D.H. 2011. Sudden clearing of estuarine waters upon crossing the threshold from transport to supply regulation of sediment transport as an erodible sediment pool is depleted: San Francisco Bay, 1999. *Estuaries and Coasts* 34:885-899

Sommer, T. and F. Mejia. 2013. A Place to Call Home: A Synthesis of Delta Smelt Habitat in the Upper San Francisco Estuary. *San Francisco Estuary and Watershed Science*. 11(2):4. http://escholarship.org/uc/item/32c8t244.

Thomson, J.R., W.J. Kimmerer, L.R. Brown, K.B. Newman, R. Mac Nally, W.A. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. *Ecological Applications* 20(5):1431-1448.

Winder, M. and A.D. Jassby. 2011. Shifts in zooplankton community structure: implications for food web processes in the upper San Francisco Estuary. *Estuaries and Coasts* 34:675-690.

York, J., B. Costas, and G. McManus. 2010. Microzooplankton grazing in green water—results from two contrasting estuaries. *Estuaries and Coasts* 34:373-385.